SYNOPSIS OF RESEARCH PROJECT

1.	**Name of the Student**	**:**	PARMAR KRISHNA GANPATBHAI
2.	**Registration No.**	**:**	1010125017
3.	**Faculty**	**:**	Agriculture
4.	**Name of the Degree Submitted for**	**:**	Ph. D.
5.	**Major Subject**	**:**	Seed Science and Technology
6.	**Minor Subject**	**:**	Genetics and Plant Breeding
7.	**Name of Major Guide**	**:**	Dr. J. B. Patel, Professor and Head, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh
8.	**Title of Research Project**	**:**	**EFFECT OF DIFFERENT SOWING DURATION, SEED PRIMING AND PLANT GROWTH REGULATORS ON SEED YIELD OF *RABI*-SUMMER BLACKGRAM** [*Vigna mungo* (L.) Hepper]

9. Introduction

In our nation, the primary source of protein for vegetarians is pulses. In addition to being a rich source of protein, they are essential to the advancement of sustainable agriculture because they maintain soil fertility through biological nitrogen fixation.

The blackgram (urad) [*Vigna mungo* (L.) Hepper] is a member of the *Fabaceae* family. It grows to a height of 30 to 100 cm and is an annual plant. Grown all over India, it is one of the major pulse crops. India is most likely the original native of blackgram (urad). Urad seed is mentioned in Vedic literature including the "*Arthasasthra*" and "*Charak Samhita*" by Kautilya. It is cultivated throughout the country in the summer and *kharif* seasons. It is grown in the summer and *kharif* seasons in northern India and in *rabi* season in southern India. Local names for blackgram include Urdbean, Urid, Mash and Biri in India; Mashkalai in Bangladesh; Maas in Nepal; Matpe in Myanmar; Thua Khiao Piu Dam and Thua Khaek in Thailand; and dau muong in Vietnam. About 3,500 - 4,500 years ago, it was domesticated in India from its wild progenitor, *V. mungo* var. *silvestris* (Chandel *et al*., 1984; Fuller and Harvey, 2006).

Because of its high nutritional value, blackgram is a crucial component of vegetarian diets in South Asia. Mature dry seeds of blackgram include around 24–26% protein, 60% carbohydrates, 1.3% fats, phosphorus (345 mg/100 g), potassium, iron (8.7 mg/100 g), calcium (185 mg/100 g) as well as numerous vitamins, including vitamin B_3 (niacin; 2 mg/100 g), vitamin A (23 IU/100 g), vitamin B_1 (thiamine; 0.42 mg/100 g) and vitamin B_2 (riboflavin; 0.37mg/100 g) along with several necessary amino acids, such as arginine, phenylalanine, leucine, lysine, valine, and isoleucine (Anonymous, 2018).

It is frequently eaten as unfermented and fermented flour (Khan *et al.,* 2021) and as a dry whole grain or split grain known as daal. Blackgram flour is used to make well known Indian dishes like idli, dosa and vada. In addition, it's a crucial component of several cuisines, such as cakes, cookies, biscuits and snacks. Its seed has potential applications in the food industry as functional foods and nutraceuticals as well as in the cosmetic and pharmaceutical industries (Pandey, 2019; Khan *et al.,* 2021).

Due to their extended shelf life, blackgram sprouts are favoured over mungbean sprouts in Thailand and Japan (Kaewwongwal *et al.,* 2015). The world's top producer of black gram is India, which accounts for 70% of the total output, with Myanmar and Pakistan coming next.

The black gram area, production and productivity in India during 2024–2025 were 31.57 lakh hectares, 22.42 lakh tonnes and 710 kg/hectare, respectively (Anonymous, 2025a), whereas in Gujarat, the area, production, and productivity during the same year were 1.14 lakh hectares, 0.90 lakh tonnes and 789 kg/hectare, respectively (Anonymous, 2025b). The crop yields 22.10 kg nitrogen per hectare, which is expected to supplement 59 thousand tonnes of urea annually (Dhivya and Ray, 2020). Over 90% of India's total pulse production is concentrated in ten states, *viz.,* Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Uttar Pradesh, Jharkhand, Telangana, Odisha, Andhra Pradesh and Tamil Nadu, with black gram making up about 10% of the total (Anonymous, 2021).

In order to meet local demand for blackgram, India has become more reliant on imports from some of the other blackgram producing nations, including Myanmar, Kenya, Mozambique, Australia and Tanzania, due to the poor rate of production increase (Anonymous, 2019). The crop's modest and steady yield (450–800 kg/ha) is one of the primary barriers to its vertical and horizontal distribution (Kaewwongwal *et al*., 2015). The potential and actual yields of pulses, particularly black gram, differ

significantly, which could be due to a variety of biotic and abiotic issues as well as poor crop management techniques (Rana *et al.,* 2016). Understanding these production constraints is essential to creating a practical strategy to increase black gram yield levels.

10. Practical Utility of the Research Project

By tackling the main obstacles that prevent the best possible seed output, this study seeks to increase the sustainability and productivity of *Rabi*-summer black gram agriculture. The need for better domestic seed production techniques is highlighted by India's rising demand for black gram. Black gram cultivation has low and stagnant output despite its potential, frequently hampered by biotic and abiotic stresses. This study focuses on determining the ideal sowing duration, analyzing seed priming methods and determining the contribution of plant growth regulators (PGRs) in boosting seed yield.

A crop's success or failure is mostly determined by weather parameters, which have a substantial impact on the plant's genetic potential and physiological expression. Any crop or variety's yield is known to depend on a number of variables, including ideal rainfall, sun radiation, temperature, soil moisture and heat units at various growth stages. Sowing time is one of the most important management techniques for increasing yields. With optimal synchronization between the vegetative and reproductive stages, an ideal sowing window guarantees improved uptake of solar energy necessary for crop growth and eventual realization of potential yield (Singh *et al*., 2010; Patidar and Singh, 2018). Black gram growth and yield are influenced by the timing of sowing; the ideal sowing time is mostly dictated by the variety being cultivated and the current agro-climatic conditions. The study aimed to evaluate how different sowing dates influence the performance of black gram to optimize yield.

The study will also examine the efficacy of seed priming, a low cost, farmer friendly method that enhances crop stand uniformity, germination and seedling vigour. When it comes to improving the crop's resistance to biotic and abiotic stresses, seed priming is especially helpful. Primed seeds are better able to develop a robust initial root system, which is necessary for adapting to challenging environmental conditions, by promoting quick and consistent seedling emergence (Heydecker, 1973).

A wide range of physiological parameters, including altered plant architecture, assimilate partitioning, promotion of photosynthesis, uptake of nutrients (mineral ions), enhanced nitrogen metabolism, promotion of flowering, uniform pod formation,

increased mobilization of assimilates to defined sinks, improved seed quality, induction of synchrony in flowering and delayed senescence of leaves, are known to be influenced by growth regulating substances or growth regulators (Sharma *et al*., 2013). According to Nagasubramaniam *et al*. (2007), these growth regulators have the potential to significantly increase crop yield and produce quality in a variety of field crops when applied as foliar spray at the appropriate crop growth stage in optimal concentration. These plant growth regulators have been viewed as software for crop productivity enhancement and plant development (Malik, 1995). The study intends to maximize PGR application in order to support strong plant growth, better resource distribution to reproductive organs and enhanced seed development, all of which lead to higher yield.

This research will provide a complete strategy to address the yield gap and overcome current production limits by integrating the factors, sowing duration, seed priming and application of PGRs. The results will give farmers practical advice on how to raise crop yields, increase seed quality and support sustainable farming methods.

11. Objectives

1. To determine the optimal seeding time to maximize seed production
2. To assess the effect of seed priming on seed yield and its attributes
3. To assess the effect of plant growth regulators on seed yield and its attributes

12. Review of Literature

The review of literature pertaining to the objectives of the present study in black gram is very scarce. Therefore, such review of other crops is reviewed and presented herewith.

12.1 Influence of different sowing duration on seed yield and its attributing parameters

Pavani *et al.* (2019) studied the effect of sowing windows on growth and yield of blackgram and performance of urdbean cultivars under rainfed surroundings. The trial involved four sowing dates (15th September, 1st October, 15th October and 1st November) as main plot treatments and four urdbean kinds as sub-plot treatments. The results showed that the crop sown on 1st October produced significantly high plant height (47.7 cm) and achieved the highest grain yield (1086 kg/ ha) compared to latterly sowing dates. The study concluded that early sowing (1st October) redounded in better performance with both high plant height and the highest grain yields.

A field trial was conducted by Subbulakshmi (2021) to determine the optimal sowing time and suited black gram variety for rainfed vertisols. The treatment combinations included three sowing dates, 39th, 41st and 43rd standard weeks (representing pre-monsoon, monsoon and post-monsoon sowing, independently), as the main plots, with four black gram kinds (Vamban Bg 6, Vamban Bg 7, NUL 7 and CO 5) as sub-plots. The results indicated that sowing during the 39th standard week (pre-monsoon) led to enhanced growth and yield parameters including plant height (26.8 cm), dry matter product (2455 kg/ha), number of capsules per plant (20.4), number of seeds per pod (4.2) and 100 seed weight (4.5 g), all contributing to higher grain yield.

Das *et al.* (2022) studied the effects of weather on growth parameters of blackgram cultivars under different sowing dates during *rabi* in North Western Plateau zone of Odisha. Treatments include five sowing dates *viz*., 8th November' 2019, 23rd November' 2019, 8th December' 2019, 23rd December' 2019 and 7th January' 2020. It was observed that when all kinds were sown on first date (8th November), the highest growth was attained which includes plant height (42.6 cm) and branches per plant (6.8), whereas least growth was attained, when sown on fourth date (23rd December).

A field study by Banerjee *et al.* (2023) was conducted in the Gangetic plains of Eastern India during the spring-summer seasons of 2020 and 2021 to estimate the effects of sowing dates and nutrient treatments on blackgram production under heat and soil humidity stress. The trial compared two sowing dates, first week of March and third week of March. The findings revealed that the crop sown in the first week of March had a longer growing period, which allowed for higher leaf area expansion, better flowering and better seed filling, eventually performing a higher seed yield compared to the crop sown in the third week of March. Also, pod number per plant, seed yield and harvest index were significantly higher in the early sown crop. The study concluded that opting the optimal sowing date can greatly enhance black gram production.

Reddemma *et al.* (2024) estimated the performance of *rabi* black gram under different sowing windows. The trial comprised four blackgram kinds *viz*., TBG-104, LBG-787, GBG-1 and PU-31 and four sowing dates *viz*., 1st fort night of October, 2nd fort night of October, 1st fort night of November and 2nd fort night of November. Results showed that varieties and dates of sowings significantly inclined all the parameters in the growth attributing characters similar as plant height, dry weight, leaf area index, and yield attributing characters like number of capsules per plant, number

of seeds per pod, 1000 seed weight, seed yield (kg/ha), haulm yield (kg/ha) and harvest index (%) and were position up the highest in PU-31 and the lowest in LBG-787. With regard to sowing windows, the highest as well as the smallest values of these parameters were observed with sowing in 1st fort night of October and 2nd fort night of November, respectively. Sowing of PU-31 on 1st fort night of October and 2nd fort night of November gave the highest seed yield (856.42 kg/ha) and haulm yield (2473.96 kg/ha), respectively. Overall, the results proved that 1st fort night of October seems to be the applicable sowing date for getting higher yield of black gram during *rabi* season, while among different kinds, PU-31 came out with the highest yield followed by GBG-1, TBG-104 and LBG-787.

12.2 Influence of different seed priming treatments on seed yield and its attributing parameters

The impact of seed priming on the growth, yield and seed quality of black gram was investigated by Abasaheb (2018). Various seed priming treatments with different chemicals were used in the experiment, including numerous hydration and foliar treatments as well as a control group (untreated seeds). Hydration with KH_2PO_4 (1%), distilled water, KNO_3 (1%), KCl (2%), $MnSO_4$ (100 ppm), $ZnSO_4$ (100 ppm), and NAA (20 ppm) were among the seed priming treatmenst. Seed priming was found to have a major positive impact on seed production and other yield contributing traits, according to the study findings. The highest yield was seen when seeds were primed with 1% KH_2PO_4 (T_2) for four hours, then 1% KNO_3 (T_4) for four hours seed priming. All priming treatments had a significantly positive impact on yield variables when compared to untreated seeds (control). In particular, compared to seeds primed with KH_2PO_4, they had better field emergence (88.61%), earlier flowering (37.67 days), higher plant height at maturity (41.27 cm), and better yield traits such as the number of flowers per plant (56.67), number of primary branches (4.87), pods per plant (25.60), seeds per pod (5.81) and seed yield per plant (9.40 g). Moreover, the seed yield per hectare was 10.49 quintals, which was much more than the control.

Nandan *et al.* (2021) studied the impact of priming on mungbean seeds with plant growth regulators on growth, biochemical alterations and yield. Bio-regulators, gibberellic acid (GA_3), salicylic acid and NAA were each applied to the seeds of mungbean (Narender Mung 1) in concentrations of 50 and 100 ppm along with a control (unpriming), and allowed to soak for 12 hours. The yield and yield contributing traits, such as number of pod clusters per plant (8.33), number of pods per plant

(48.26), length of the pod (7.66 cm), number of seeds per plant (416.66), number of seeds per pod (10.33), weight of 100 seeds (3.92 g), yield of seeds per plant (14.36 g), yield of seeds (11.66 q/h) and harvest index (36.06%) were all shown to be statistically superior with seed priming of GA_3 (100 ppm) over control. NAA (100 ppm) was the second-best priming treatment.

Mandod (2022) investigated the effects of several priming therapies on the germination, development and yield of blackgram. Several priming treatments were examined in the study, including hydro priming, varying concentrations of salicylic acid, PEG-6000, GA_3, and KH_2PO_4, all of which were administered for one hour. According to the findings, the highest yield was produced by seeds primed with 7.5% PEG (T_8) followed by 1.5% KH_2PO_4 (T_{11}). Compared to untreated seeds, seeds treated with 7.5% PEG showed better field emergence (92.56%), earlier flowering (26.93 days), higher plant height at maturity (48.87 cm), more primary branches (8.67), more pods per plant (25.82) and higher seed yield per plant (9.61 g). Other yield characteristics, such as pod length (6.44 cm), days to maturity (61.47) and harvest index (25.88%) were also considerably higher than the untreated control (T_1).

Zade *et al.* (2024) studied the impact of various seed priming treatments on chickpea growth, seed yield and yield attributing characteristics using chickpea cv BDNGK-798 during *rabi* season of 2022–23. The seed of the chickpea cv. Virat (BDNGK-798) was primed using various growth regulators, including Gibberellic acid at 100 ppm, Indole Acetic Acid at 200 ppm, Salicylic Acid at 100 ppm, $KN0_3$ at 100 ppm, PEG at 7% and $CaCl_2$ at 2% in addition to the control. Days to 50% flowering, days to physiological maturity, plant height (30 DAS) (cm), plant height (60 DAS) (cm), primary branches per plant (30 DAS), primary branches per plant (60 DAS), secondary branches per plant (60 DAS), number of pods per plant, pod weight per plant (g), seed yield per plant (g), biological yield per plant (g) and seed yield per plot (kg) were among the characteristics documented. Every priming therapy was shown to be more effective than the control. However, the calcium chloride ($CaCl_2$) treatment at 2% proved to be the most effective of all treatments, particularly in terms of yield and yield related traits. It resulted in higher plant height and a higher number of primary branches per plant, which indirectly affected the number of pods per plant, weight of the pods per plant and the seed yield per plant.

Rashid *et al*. (2025) assessed the effects of different seed priming methods on the germination development and yield of mungbean with five priming techniques,

hydropriming, halopriming (2% NaCl), hormonal priming utilizing gibberellic acid (GA_3) at 100 and 200 ppm and control (without primed) in three varieties, BARI Mung 6, BARI Mung 7 and BARI Mung 8. GA_3 (200 ppm) dramatically improved plant height, number of branches, biomass and yield components, including pods per plant, pod length, seeds per pod, 1000 seed weight and total yield. The highest yield (565.67 kg/ha) was seen in BARI Mung-7 treated with 200 ppm GA_3. On the other hand, priming with 2% NaCl resulted in the worst performance with BARI Mung-6 producing just 33.33 kg per hectare yield. The findings imply that, under the tested circumstances, the best way to boost mungbean yield is to prime BARI Mung-7 with GA_3 at 200 ppm for 24 hours.

12.3 Influence of foliar spray of plant growth regulators on yield parameters

Rawat *et al.* (2023) assessed the effects of various amounts of salicylic acid on the development and yield parameters of blackgram at 20-, 40- and 60-days following planting. The treatments consisted of foliar sprays with varying amounts of salicylic acid (50 ppm, 100 ppm, and 150 ppm). The use of 150 ppm salicylic acid at 60 DAS (T_{10}) resulted in notable increases in yield characteristics and growth parameters. This treatment resulted in higher plant height (36.50 cm and 38.10 cm at 70 DAS and maturity), more leaves per plant (8.66, 23.66, and 22.0 at 35 DAS, 70 DAS and maturity), and more branches per plant (3.9, 8.60, and 10.33 at 35 DAS, 70 DAS, and maturity). In terms of yield components, same treatment produced the highest number of pods per plant (46.00), seed yield per plant (6.66 g), 100 seed weight (4.41 g) and grain yield (10.35 q/ha). The harvest index was also maximized at 30.30%. The findings found that foliar application of salicylic acid at 150 ppm was the most efficient therapy for improving the growth, yield and general performance of blackgram in rainfed environments, as compared to the control, which noted the lowest values.

The impact of foliar applications of salicylic acid and naphthalene acetic acid (NAA) on growth and yield characteristics of mungbean was investigated Yadav *et al.* (2024). The seven treatments that were examined were as follows: control (T_1) (distilled water spray at 30 and 40 DAS), foliar spray of SA @ 50 ppm at 30 DAS (T_2-), foliar spray of SA @ 80 ppm at 30 DAS (T_3), foliar spray of NAA @ 50 ppm at 30 DAS (T_4), foliar spray of NAA @ 80 ppm at 30 DAS (T_5), foliar spray of NAA @ 50 ppm at 40 DAS (T_6) and foliar spray of NAA @ 80 ppm at 40 DAS (T_7). The findings revealed that the treatment T_5 (foliar application of NAA at 80 ppm at 30 DAS) significantly improved growth parameters such plant height (cm), total number of

branches per plant, total dry biomass (g/plant), and yield and yield attributes such number of pods per clusters, number of pods per plant, pod length (cm), number of seeds per plant, and number of seeds per pod over the control. The next best treatment was Treatment T_7, which involved applying NAA at 80 ppm *via* foliar application at 40 DAS.

Amisha *et al.* (2025) investigated the impact of plant growth regulators on the agronomic performance of clusterbean. The experiment included 10 treatments: T_1 (control), T_2 (IAA at 50 ppm), T_3 (IAA at 10 ppm), T_4 (IAA at 150 ppm), T_5 (GA_3 at 50 ppm), T_6 (GA_3 at 100 ppm), T_7 (GA_3 at 150 ppm), T_8 (NAA at 50 ppm), T_9 (NAA at 100 ppm) and T_{10} (NAA at 150 ppm). Variance analysis showed that there was a large variation between the treatments for all the traits examined. The outcome suggests that using IAA and GA_3 led to improved growth and yield characteristics, nutrient absorption from the soil and clusterbean economics, making it recommendable to farmers.

Kapoor *et al.* (2025) examined the impact of foliar application of various compounds on the development of field pea under terminal heat stress. Twelve different treatments were used in the trial. Under conditions of extreme temperature stress, the data revealed that foliar treatment of salicylic acid at 400 ppm significantly enhanced the plant height (85.15 cm), lowered the days to 50% flowering (61.66 days), and shortened the days to maturity (125 days). The overall improvement in plant development and productivity caused by salicylic acid and thiourea was brought about by the strengthening of the antioxidant defense mechanism. As a result, the foliar administration of these exogenous substances may be a useful and successful strategy for lowering heat stress and sustaining field pea output, even in environments with rising temperatures.

Sharma *et al.* (2025) assessed the reaction of clusterbean to foliar treatment of plant growth regulators (PGRs) by Using cv. Pusa Navbahar. Ten treatments were examined: control (T_1), NAA at 50, 100 and 150 ppm (T_2 - T_4), GA_3 at 50, 100 and 150 ppm (T_5 - T_7) and cycocel/CCC at 750, 1500 and 2250 ppm (T_8 - T_{10}). The tallest plants were produced by GA_3 at 150 ppm (T_7) at 30, 60 and 90 DAS (21.84, 47.32, and 82.38 cm, respectively). The maximum number of clusters per plant (13.87) and pods per cluster (4.33), as well as improved yield characteristics such as pods per plant (60.06) and pod length (9.53 cm), were all recorded at 750 ppm of CCC (T_8). Under NAA at 100 ppm (T_3), early flowering was seen with 50% blooming in 45.85 days.

With CCC at 750 ppm (T_8), the highest values for seed yield (62.46 g/plant, 2775.97 g/plot and 9253.24 kg/ha), protein content (24.22%), net return (₹124,008), and benefit: cost ratio (3.91) were achieved. In Jaipur's semi-arid climate, a 750-ppm concentration of CCC was found to be the most effective treatment for increasing clusterbean productivity, seed quality and economic viability.

13. Materials and Methods

13.1 Location : Sagdividi Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University

13.2 Year and season of experiment : *Rabi*-Summer 2025-26 and 2026-27

13.3 Crop and variety : Black gram and GU-2

13.4 Experimental design : Split Plot Design

13.5 Number of replications : 3 (Three)

13.6 Spacing : 45 cm × 5-10 cm

13.7 Plot size : 4 m × 0.9 m

13.8 Treatment details :

Factor I : Date of sowing (D)

D_1 : First week of January

D_2 : Fourth week of January

D_3 : Third week of February

Factor II : Seed priming (P)

P_0 : No priming (control)

P_1 : Hydropriming (with water, 8 h)

P_2 : Bio-priming (Plant growth promoting *Rhizobacteria*) (5%, 8 h)

P_3 : Osmo-priming (PEG 6000) (5%, 8 h)

P_4 : Nutri-priming ($ZnSO_4$) (1%,

8h)

P_5 : Chemical priming (KNO_3) (1%, 8 h)

Factor III : Foliars pray (F) (each at 30 and 45 days after sowing)

F_0 : Control

F_1 : NAA @ 400 ppm

F_2 : SA @ 400 ppm

F_3 : Cycocel @ 500 ppm

Total treatment combinations: 3 × 6 × 4 = 72

13.9 Observations to be recorded

Ten plants in each plot will be randomly selected and their average will be used for recording the seed yield and yield attributing characters, except days to 50 per cent flowering and days to maturity. Days to 50 per cent flowering and days to maturity were recorded on plot basis.

13.9.1 Days to 50 per cent flowering

The number of days will be recorded from the date of sowing to flowering initiation in 50 per cent plants in a plot.

13.9.2 Days to maturity

Number of days will be recorded from the date of sowing to 80 per cent plants in a plot attaining physiological maturity.

13.9.3 Plant height at maturity (cm)

The plant height will be measured in centimeter from ground level to the tip of the plants at the time of maturity.

13.9.4 Number of effective branches per plant

Total number of pods bearing primary branches arising on main axis of each randomly selected plant will be counted at the time of maturity.

13.9.5 Number of pods per plant

Total number of pods per plant will be counted from each selected plant at the time of harvest. Empty pods will not be included into observation.

13.9.6 Number of seeds per pod

Number of seeds per pod from ten randomly selected pods of each selected plant will be collected separately and average number of seeds per pod will be recorded.

13.9.7 Number of seeds per plant

Number of seeds per plant from ten randomly selected plants will be collected separately and average number of seeds per plant will be recorded.

13.9.8 Seed yield per plant (g)

Seeds harvested from ten randomly selected plants will be dried, cleaned and weighed in grams on an electronic balance and averaged.

13.9.9 Seed yield per ha (kg/ha)

The total pods from net plot of each treatment will be threshed separately and cleaned to obtain seeds and their weight will be recorded separately and average seed yield per plot will be worked out. The seed yield per plot will be converted on hectare basis (kg/ha).

13.9.10 Biological yield per plant (g)

Total biomass of ten randomly selected plants along with pods (excluding roots) will be dried and weighed.

13.9.11 Harvest index (%)

Harvest index is the ratio of seed yield to biological yield. Harvest index will be calculated as per the following formula (Donald, 1962). The average will be worked out and reported in percentage.

$$\text{Harvest index (\%)} = \frac{\text{Seed yield per plant}}{\text{Biological yield per plant}} \times 100$$

13.9.12 Test weight (g)

Thousand seeds from each treatment combinations will be counted manually and the average weight will be recorded as test weight in gram.

14. Statistical Analysis

The experiment data collected from field experiment will be analysed statically by adopting Split Plot Design as described by Steel and Torrie (1980).

15. References

Abasaheb, M. C. P. (2018). Effect of seed priming on growth, yield and seed quality of urdbean (*Vigna mungo* L.) M.Sc. (Agri.) Thesis (Unpublished) Submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri.

Amisha, Kumar, N., Singh, J., Sharma, A., Kumar, R. and Sharma, S (2025). Influence of plant growth regulators on agronomic performance in clusterbean (*Cyamopsis tetragonoloba* L. Taub.). *International Journal of Agronomy,* **8**(10): 200-209.

Anonymous. (2018). USDA National Nutrient Database. Available at: https://ndb.nal.usda.gov/ndb/foods/show/4821?manu=&fgcd=&ds, Accessed on December 05, 2026.

Anonymous. (2019). Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, India. Available at: https://agriwelfare.gov.in/sites/default/files/Pulses%20profie%20for%20the%20month%20of%20September,%202019%20(Updated%20as%20on%2024.09.2019).pdf, Accessed on December 10, 2025.

Anonymous. (2021). Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, India. Third Advance Estimates of Production of Food grains for 2020-21 (Government of India). Available at: https://static.pib.gov.in/WriteReadData/specificdocs/documents/2021/may/doc202152541.pdf, Accessed on December 10, 2025.

Anonymous. (2025a). Unified Portal for Agricultural Statistics. Department of Agriculture and Farmers Welfare. Available at https://upag.gov.in/dashreports/allindiaapy, Accessed on December 15, 2025.

Anonymous. (2025b). Unified Portal for Agricultural Statistics. Department of Agriculture and Farmers Welfare. Available at https://upag.gov.in/area-productivity. Accessed on December 15, 2025.

Banerjee, P., Bhattacharya, P., Kumari, V. V., Bera, A. and Nath, R. (2023). Modification in bio-physical properties of spring-summer black gram [*Vigna mungo* L. Hepper] through optimization of sowing dates and nutrient management towards production sustainability. *Field Crops Research*, **29**(1): 108767. doi.org/10.1016/j.fcr.2022.108767.

Chandel, K. P. S., Lester, R. N. and Starling, R. J. (1984). The wild ancestors of urid and mung beans [*Vigna mungo* (L.) Hepper and *V. radiata* (L.) Wilczek]. *Botanical Journal of the Linnean Society*, **89**(1): 85-96.

Das, D., Patel, N. and Biswasi, S. K. (2022). Weather effects on growth parameters of blackgram cultivars under different sowing dates during *Rabi* in North Western Plateau zone of Odisha. *Journal of Pharmacognosy and Phytochemistry*, **11**(2): 258-260.

Dhivya, R. S. and Ray, L. I. P. (2020). Performance of black gram (*Vigna mungo* L. Hepper) with organic amendments. *Indian Journal of Hill Farming*, **33**(1): 10-18.

Donald, C. M. (1962). In search of yield. *Journal of the Australian Institute of Agricultural Science,* **28**: 171-178.

Fuller, D. Q. and Harvey, E. L. (2006). The archaeobotany of Indian pulses: Identification, processing and evidence for cultivation. *Environmental Archeology,* **11**(2): 219-246.

Heydecker, W. (1973). Germination of an Idea: "The Priming of Seeds". Report of University of Nottingham, School of Agriculture, 1973-1974, pp 50-67

Kaewwongwal, A., Kongjaimun, A., Somta, P., Chankaew, S., Yimram, T., and Srinives, P. (2015). Genetic diversity of the blackgram [*Vigna mungo* (L.) Hepper] gene pool as revealed by SSR markers. *Breeding Science*, **65**(2): 127-137.

Kapoor, N., Maurya, C. L., Yadav, V. K., Praanjal, P., Pant, M., Jyoti, A., Nayak, A. K., Kumar, A., Singh, J., Singh, Y. P., Singh, A. P. and Babu, S. (2025). Effect of foliar application of different chemicals on the growth of fieldpea (*Pisum sativum var. arvense* L.) under terminal heat stress. *Journal of Advances in Biology and Biotechnology,* **28**(11): 748-757.

Khan, F., Nayab, M., Ansari, A. N. and Zubair, M. (2021). Medicinal properties of Mash (*Vigna mungo* (L.) Hepper): A comprehensive review. *The Journal of Drug Delivery and Therapeutics*. **11**(3-S): 121-124.

*Malik, C. P. (1995). Plant growth regulators; software for plant development and crop productivity. Presidential Address (Botany section). *Indian Science Congress Association*, **35**: 1-5.

Nagasubramaniam, A., Pathmanabhan, G. and Mallika, V. (2007). Studies on improving production potential of baby corn with foliar spray of plant growth regulators. *Annual Review of Plant Physiology and Plant Molecular Biology*, **21**(2): 154-157.

Nandan, R., Yadav, R. K., Singh, S. P., Singh, A. K. and Singh, A. K. (2021). Effect of seed priming with plant growth regulators on growth, biochemical changes and yield of mung bean (*Vigna radiata* L.). *International Journal of Chemical Studies*, **9**(1): 2922-2927.

Pandey, S. (2019). Review on medicinal importance of *Vigna* genus. *Plant Science Today*. **6**(4): 450-456.

Patidar, K. and Singh, T. (2018). Effect of varieties and dates of sowing on growth, yield and quality of black gram (*Vigna mungo* L.). *Annals of Plant and Soil Research*, **20(4)**: 428-431.

Pavani, P., Sumesh Kumar, M., Venkata Rao, P. and Victorbabu, B. R. (2019). Effect of sowing windows on growth and yield of blackgram and performance of urdbean cultivars under rainfed environments. *International Journal of Agricultural and Statistical Sciences*, **15**(1): 303-306.

Mandod, P. G. (2022). Responses of black gram (*Vigna mungo* L.) to different priming treatments on germination, growth and yield. Ph.D. (Agri.), Thesis (Unpublished) Submitted to Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

Rana, J. C., Gautam, N. K., Gayacharan, Singh, M., Yadav, R., Tripathi, K., Yadav, S. K., Panwar, N. S. and Bhardwaj, R. (2016). Genetic resources of pulse crops in India: An overview. *Indian Journal of Genetics and Plant Breeding*, **76(4)**: 420-436.

Rashid, M. M., Mim, A. H., Turjo, A. A., Rahman, M. M., Sikdar, M. S. I., Islam, S. S. and Khomphet, T. (2025). Comparative effects of seed priming approaches on germination, growth and yield of mungbean. Asian Journal of Agriculture and Biology, 2025: e2025138. DOI: https://doi.org/10.35495/ajab.2025.138.

Rawat, D. K., Khan, M. A., Kumar, A., Prasad, J., Prajapati, S. K. and Prajapati, B. K. (2023). Response of different levels of salicylic acid on growth characteristics, chlorophyll content, yields attributes and yield of black gram (*Vigna mungo* L.) under Rainfed Condition. *International Journal of Environment and Climate Change,* **13**(3): 232-242.

Reddemma, K., Sreenivas Reddy, M. and Tej, M. K. (2024). Performance of *rabi* black gram (*Vigna mungo* L.,) under different sowing windows. *Journal of Experimental Agriculture International*, **46**(6): 30-44.

Sharma, N., Shukla, U., Dhayal, L. S. and Yadav, I. R. (2025). Effect of different plant growth regulators on growth, yield and quality of cluster bean (*Cyamopsis tetragonoloba* L.Taub.). *Journal of Experimental Agriculture International*, **47(12)**: 464-471.

Sharma, P., Sardana, V. and Kandhola, S. S. (2013). Dry matter partitioning and source-sink relationship as influenced by foliar sprays in groundnut. *The Bioscan*, **8**(4): 1171-1176.

Singh, G., Sekhon, H. S., Ram, H., Gill, K. K. and Sharma, P. (2010). Effect of date of sowing on nodulation, growth, thermal requirement and grain yield of *Kharif* mungbean genotypes. *Journal of Food Legume,* **23**(2): 132-134.

Steel, R. G. D. and Torrie, J. H. (1980). *Principles and Procedures of Statistics*, New York, Mcgraw Hill Book Company. p137.

Subbulakshmi, S. (2021). Influence of sowing dates on yield of black gram varieties under rainfed condition. *Journal of Crop and Weed*, **17(3)**: 41-46.

Yadav, R., Singh, S., Singh, S., Singh, P. K., Tripathi, D., Yadav, N., and Yadav, R. K. (2024). Influence of foliar application of salicylic acid and naphthalene acetic acid (NAA) on biochemical and yield contributing traits in mungbean (*Vigna radiata* L.). *Plant Archives,* **24**(1): 265-269.

Zade, V. R., Misal, A. M., Wankhade, M. P., Rathod, A. H. and Ingole, R. R. (2024). Effect of seed priming treatments on seed yield and seed quality parameters in chickpea (*Cicer arietinum* L.) cv BDNGK-798. *Seed Research*, **52**(2): 1030-134.

---

*Original not seen

(Parmar Krishna G.) **(J. B. Patel)**